**International Journal of Electronics, Communication & Instrumentation Engineering Research and Development (IJECIERD)**
**ISSN(P): 2249-684X; ISSN(E): 2249-7951**
**Vol. 5, Issue 3, Jun 2015, 81-88**


# CONTENT BASED IMAGE RETRIEVAL USING COLOR AND TEXTURE

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## ABSTRACT

On internet there is large number of images present. To search an image of our interest is key issue. Generally images are fetched by its annotation however this is not much effective and efficient. Now, images are retrieved using their features which is very efficient technique called as content based image retrieval (CBIR). Different features are considered in this process; for e.g. color, shape, texture etc. Out of this for black-white images generally texture features are considered for better resuls whereas for color images color features are important. This paper aims to improve the performance of CBIR using texture and color features using Curvelet Transform (CvT).

**KEYWORDS:** Image Retrieval, Color Histogram, Color Spaces, Precision and Recall, Curvelet Transform, CBIR, Texture, WBCHIR, CTDCIRS

## I. INTRODUCTION

Nowadays, due to the availability of large storage spaces, huge number of images have been produced and stored around the world. With this huge image database, people want to search it and make use of the images in it. Here comes the challenge of image retrieval and researchers try to find out accurate ways of searching images. Basically, images can be retrieved in two ways, firstly, text based, and secondly, content-based or query by example based. Text based image retrieval approach is very well known and widely used. In this process users are provided a text area to enter the key words on the basis of which image searching is done. It is widely used in Google web based image searching technique. Though the concept is very familiar to us, this approach has two notable drawbacks. (1) The images in database are annotated manually by annotators using key words, which is a very time consuming process [1] for a large database. (2) The retrieval solely depends on the human perception based text annotation as shown in Figure 1.

**Figure 1: First Page of Google Image Search for Keyword ‘Rose’ [2]**

As shown in this figure 1, the forth image is not the image of rose then also it is retrieved because it is annotated by name ‘Rose’. So, this is the biggest disadvantage of text based image retrieval system. The consequence is that there is

significant inconsistency in understanding of image content by different annotators, for ex. An image containing grass and flowers can be annotated as 'grass', 'flower' or 'nature', so the key words vary a lot and retrieval results are usually very poor.

To avoid these problems, the second approach, Content-based image retrieval (CBIR) has been proposed by researchers. The term CBIR originated in the early 1990's [1]. Since then it is an ongoing process. CBIR is different from text based image retrieval in the sense of it uses low-level features like texture color and shape to represent images and retrieve relevant images to your query image form huge image database. Out of these above mentioned features color and texture are very important features in concern with human perception system. So, if we use the same features to retrieve images then it will give better results. The Color Selection exploited CBIR system [3], facilitates query-by-color. It is based on 11 color categories, used by all people, while thinking of and perceiving color. Then the RGB color spaces transformed to YUV color space as feature vectors are used for retrieval of images [4]. The texture feature extraction techniques can be broadly classified into spatial methods and spectral methods. In spatial approach, most techniques depend on calculating values of low order statistics from query and stored database images [6]. These methods compute texture features such as the degree of contrast, coarseness, directionality and regularity [1, 6, 7]; or periodicity, directionality and randomness [8]. Alternative methods of texture analysis for image retrieval include the use of Gabor filters [9], wavelet [10] and DCT [11]. Statistic techniques suffer from insufficient number of features and sensitive to image noise. The spectral methods in literature, however, do not capture edge information accurately.

In this paper, color and texture based image retrieval technique with discrete curvelet transform and color histogram is proposed. This technique combines advantages of both color-based image retrieval and texture-based image retrieval. In this paper we describe theory and implementation of technique with algorithm for color feature extraction and texture feature extraction.

The rest of paper is organized as following. In section II, we describe block diagram of system. In section III, Feature extraction algorithm is described. Retrieval performance test will be shown in section IV. Finally the experimental work and the conclusions are presented in section V and section VI respectively.

## II.BLOCK DIAGRAM AND DESCRIPTION OF SYSTEM

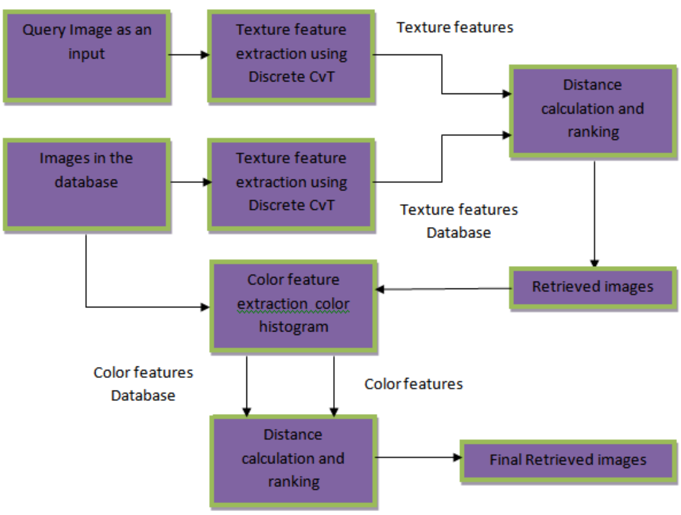


**Figure 2: Block Diagram of System**

As shown in Figure 2, the query image, i. e., an image for which we have to find out similar images, acts as input to the system. That query image is given to texture feature extraction using discrete curvelet transform block, in that block the texture features for given images are extracted and the curvelet transform is used for that purpose. The description of curvelet transform is given in section III. The image database is created with same sized images inclusion and its texture features are extracted using discrete curvelet transform to form texture feature database. Then texture features of query image and images present in database are compared, distance of each image from query image is calculated and ranking is given in ascending order distances. Then according to ranking first 25 images are retrieved and given to the color feature extraction block, here color features are extracted then distance calculation and ranking is done using comparison of features of images in database and query image. Then we get the final retrieved 10 images according to ranking.

We used the curvelet transform of level 4 and level 5 for extracting texture features and compared them with existing systems based on practical results.

## III. ALGORITHMS USED IN SYSTEM

### A. Texture Feature Extraction

The digital curvelet transform is taken on a 2-D Cartesian grid, $f[m, n]$, $0 \leq m < M$, $0 \leq n < N$,

$$C^D(a,b,\theta) = \sum_{\substack{0 \leq m < M \\ 0 \leq n < N}} f[m,n]\,\psi^D_{a,b,\theta}[m,n] \tag{1}$$

Discrete curvelet transform is implemented using the wrapping based fast discrete curvelet transform. Basically, multiresolution discrete curvelet transform in the spectral domain uses the advantages of fast Fourier transform (FFT). During FFT, both the image and the curvelet at a given scale and orientation are transformed into the Frequency domain. The convolution of the curvelet with the image in the spatial domain then becomes their mutliplication in the Fourier domain. At the end of this process, we obtain a set of curvelet coefficients by applying inverse FFT to the spectral product. This set contains curvelet coefficients. The complete feature extraction process is illustrated in Figure 3

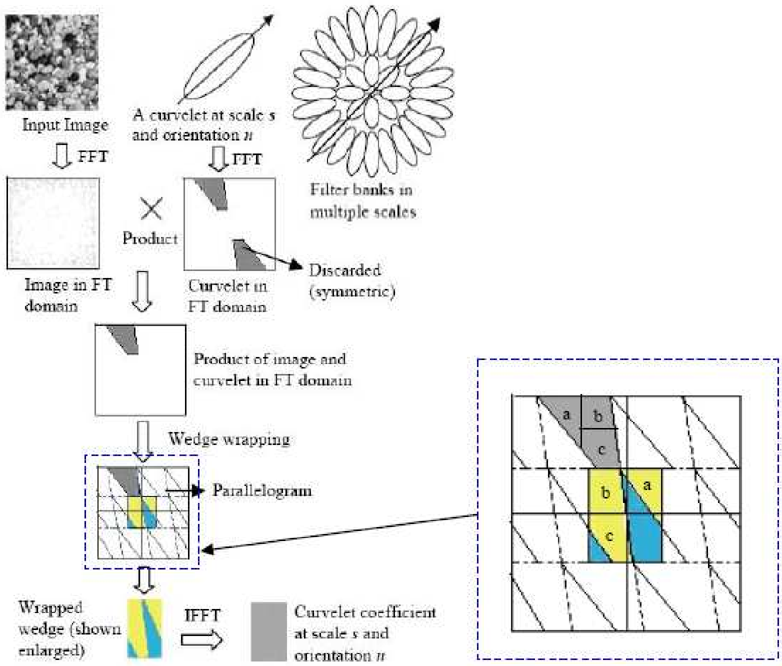


**Figure 3: Fast Discrete Curvelet Transform**

As the curvelet coefficients have been generated, the mean and standard deviation of these coefficients are computed. Thus, for each curvelet, we obtain two texture features. If n curvelets are used for the transform, 2n texture features are obtained. This results in a 2n dimensional texture feature vector which represents each image in the feature database. The system then compares the query feature vector with all the feature vectors in the database using L2 distance:

$$d(Q,T) = \Big(\sum_{i=0}^{2n-1} (Q_i - T_i)^2\Big)^{1/2} \tag{2}$$

Where **Q**={$Q_0$, $Q_2$, …, $Q_{2n-1}$} = the feature vector of the query or input image, and **T**={ $T_0$, $T_2$, …, $T_{2n-1}$} = the feature vector of target image in the database.

## A. Color Feature Extraction

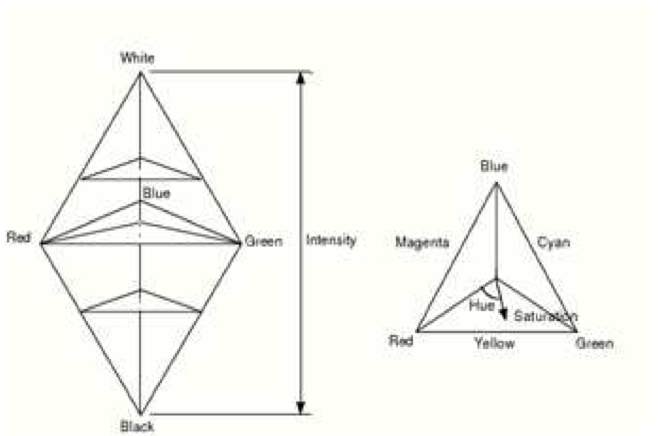


**Figure 4: HSI Color Space**

- Input Query Image
- Call 'cal histogram' function and get an hsv converted output along with histograms plotted as given below
    - Take Query Image in RGB. Using 'input' function (input(enter query image,s);)
    - Change RGB to HSI using 'rgb2hsv' function,(rgb2hsv(query image)).

The calculations for HSI is done using

$$H = \begin{cases} \theta & if\ B \le G \\ 360 - \theta & if\ B \ge G \end{cases}$$

$$\theta = \cos^{-1}\{\frac{\frac{1}{2}[(r-g)+(r-b)]}{[(r-g)^2+(g-b)(r-b)]^{\frac{1}{2}}}\}$$

$$S = 1 - \frac{3}{(r+g+b)} Min(r,g,b), I = \frac{1}{3}(r+g+b) \tag{3}$$

- For histogram calculation take size of HSV image, ([M, N, ttt]=size(hsv image)).
- For plotting histogram keep range as 0-1 in steps of 0.1, and plotting is done.
- Plotting is done by calculating the variables for histogram function by rounding off the HSV values.

- Calculate length of histogram for training samples (in order to give same length for database images).
- Upper and Lower Threshold values.
- Apply Limits for mesh grid with range of 0-1 insteps of 0.1 and 0.05.
- 3-d interpolation for query image. The Interpolation is done by using the function 'interp3'.

$$d(H(im_m), H(im_n)) = \sum_{i=1}^{N} |H(im_m, i) - H(im_n, i)|$$

$$d(H(im_m), H(im_n)) = \sum_{i=1}^{N} min(H(im_m, i) - H(im_n, i)) \tag{4}$$

- Interpolation means, to Calculate value of a function between the values that are already known.
- Now the Histogram Interpolation is done for query image and database images, by initializing threshold values as 0.01 and 0.8.
- In the above two equations, first equation- calculates the difference between query image and database image histograms. While the second equation takes the color histogram intersecting with histogram intersection difference giving out the HSI values.
- Go for all database images, and perform interpolation of each image in database with length equal to T samples.

- Calculate Absolute value of query and database interpolated values using the given formulae as in variable ‘fine’.
- Apply Lower Threshold for fine Variable output.
- Store the upper threshold applied value as fine2.
- Compute Similarity Measure using mean and length of the 2 threshold applied output.

## IV. RETRIEVAL PERFORMANCE TEST

In this section, we find the performance of the curvelet feature in terms of retrieval accuracy. The widely used standard WANG color database is used in the test. The database consists of different categories of natural and manmade texture and color images; each image has the same size. In total, the image database consists of 1000 images from different categories.

We apply the curvelet feature extraction process described in section III to each of the 1000 images in the database and index each of the images using the curvelet feature vector. For the discrete curvelet transform, two tests are experimented. In the first test, images are decomposed using 4 levels curvelet transform. In the second test, images are decomposed using 5 levels curvelet transforms.

The commonly used performance measurement, precision-recall pair, is used for the calculation of retrieval performance. Precision $P$ is defined as the ratio of the number of retrieved relevant images $r$ to the total number of retrieved images $n$, i.e. $P = r/n$. Precision $P$ measures the accuracy of the retrieval. Recall $R$ is defined as the ratio of the number of retrieved relevant images $r$ to the total number $m$ of relevant images in the whole database, i.e. $R = r/m$. Recall $R$ measures the robustness of the retrieval.

$$P = \frac{No.of\ relevant\ images\ retrieved}{Total\ no.of\ images\ retrieved} \tag{5}$$

$$R = \frac{No.of\ relevant\ images\ retrieved}{Total\ no.of\ images\ relevant\ images\ in\ DB}$$

## V. EXPERIMENT

This method has been implemented using MATLAB 7.3 and tested on a general-purpose WANG database [12] consist of 1,000 images of the Corel stock photo, in JPEG format of size 384 X 256 and 256 X 386. The search is usually based on similarity rather than the exact match. We have followed the image retrieval technique, as described in the section II.

The Curvelet transform retrieval method, as discussed in section II, has been used to study the image retrieval using and the performance of the proposed image retrieval technique has been evaluated by comparing the results with the results of different authors [13, 14, 4, 15 and 16] as shown in the Table 1. The effectiveness of the Curvelet transform retrieval method is evaluated by selecting 10 query images under each category of different semantics. For each query, we examined the precision of the retrieval, based on the relevance of the image semantics. The semantic relevance is determined by manual truthing the query image and each of the retrieved images in the retrieval. The precision values, calculated by using the equation 5 and also the average precision using the same equation as shown in Table 1. These results clearly show that the performance of the proposed method is better than the other methods.

**Table 1: Precision of the Retrieval by Different Methods**

| Category | Curvelet with level 4 | Curvelet with level 5 | WBCH | CH | CCM, DBPSP, CHKM | Color and Texture | Color, Texture and Shape | CTDCIRS |
|---|---|---|---|---|---|---|---|---|
| African People | 1 | 1 | 0.65 | 0.72 | 0.68 | 0.75 | 0.54 | 0.562 |
| Beach | 0.7 | 0.6 | 0.62 | 0.53 | 0.54 | 0.6 | 0.38 | 0.536 |
| Building | 0.4 | 0.5 | 0.71 | 0.61 | 0.56 | 0.43 | 0.30 | 0.61 |
| Buses | 0.9 | 0.9 | 0.92 | 0.93 | 0.89 | 0.69 | 0.64 | 0.893 |
| Dinosaurs | 1 | 1 | 0.97 | 0.95 | 0.99 | 1 | 0.96 | 0.984 |
| Elephants | 0.8 | 0.8 | 0.86 | 0.84 | 0.66 | 0.72 | 0.62 | 0.578 |
| Flowers | 1 | 1 | 0.76 | 0.66 | 0.89 | 0.93 | 0.68 | 0.899 |
| Horses | 1 | 1 | 0.87 | 0.89 | 0.8 | 0.91 | 0.75 | 0.78 |
| Mountains | 0.1 | 0.2 | 0.49 | 0.47 | 0.52 | 0.36 | 0.45 | 0.512 |
| Food | 0.9 | 1 | 0.77 | 0.82 | 0.73 | 0.65 | 0.53 | 0.694 |
| **Average Precision** | **0.78** | **0.8** | **0.762** | **0.742** | **0.726** | **0.704** | **0.585** | **0.7048** |

## VI. CONCLUSIONS

Content based image retrieval is a challenging method of capturing relevant images from a large storage space. Although this area has been explored for decades, no technique has achieved the accuracy of human visual perception in distinguishing images. Whatever the size and content of the image database is, a human being can easily recognize images of same category. From the very beginning of CBIR research, texture is considered to be a primitive visual cue like the color and shape of an image. Though image retrieval using texture and color features is not a brand new approach, there is still scope to enhance the retrieval accuracy with a proper representation of texture and color features.

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